An evaluative and evidence-based report

of the project

Studying the incubation temperature of a nesting population of olive ridley turtles (*Lepidochelys olivacea*) in the coast of Maharashtra with advance data logging system (Phase III).

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Executive Summary

The negative impact of climate change on sea turtle biology and nesting site is evident from studies around the world. Olive ridley turtle one of the most populous among the seven-sea turtle has nesting sites distributed in the tropical belt. Irrespective of its vulnerable status like other sea turtles it is considered as a flagship species for the conservation of both marine and beach habitat. The west coast of India which harbours their nesting site is a part of the Indian ocean west regional managing unit (RMU) for their conservation. Maharashtra coast in the west coast of India along with Oman plays a significant role in maintaining their population in Indian ocean west RMU. Through the conservation efforts taken by Maharashtra State Forest Department for almost two-decade, a well-established system is observed protecting their nesting sites. In 2019 a temperature datalogger project was initiated and extended for two years. An indigenously developed temperature datalogger having a GSM facility for data transfer working on power backup given by solar panels were installed on seven major nesting sites across Maharashtra. Each datalogger had eight sensors to collect simultaneously the incubation temperature of the nests. It gave an estimation of the sex ratio of released hatchlings with scientific evidence of an increase in incubation temperature. The correlation of hatchling mortality with increased incubation temperature in the study site was evident and mitigation efforts to reduce that was studied. Three years of the project gave a good insight about the various effect of high temperature on the protected nest viz: hatchlings trapped inside the nest due to hardening of sand, late-stage mortality of embryos, increase incidence of predatory ant attack due to increase in incubation temperature. The protocols to overcome these effects were standardised after practical implementation on the field site. Another indirect effect of climate change like an increase in sea water and shift in nesting season from winter to summer was observed. Mitigation of the incubation temperature was done in different ways and evaluated with the help of temperature datalogger and emergence success. Green shade net used to cover the hatchery solely does not serve the purpose of keeping the incubation temperature below the threshold temperature of 33^0C. The intermittent sprinkling of water or keeping a wet jute bag over an inverted cane basket kept on the nest helped in reducing the temperature. These methods are used regularly in hatchery management globally. Through this study for the first time, we have observed a natural way to control the incubation temperature below 33^0C by erecting the hatchery in a sparsely dense casuarina plantation. Mitigation of incubation temperature with the help of a data logger is a definitive way to increase emergence success, release of healthy hatchlings and balance the sex ratio of hatchlings. The conservation management of olive ridley in Maharashtra has entered an advanced stage through this project.

Acknowledgement

I would like to express my gratitude to my PhD supervisor Dr K Sivakumar for his unconditional support. We, both are thankful to Shri Virendra Tiwari sir APCCF (Mangrove Cell) and Director of Mangrove and Marine Biodiversity Conservation Foundation and Ms Neenu Somraj madam DCF (Mangrove Cell) for their keen interest in the project and sanctioning grants for phase III of the project. I extend my gratitude to Dr Manas Manjrekar who with his scientific understanding has supported the project unconditionally.

This year as the previous year there was a constant pressure of COVID pandemic and lockdown. In my absence during the lockdown, the hatchery managers continued the project and provided me with substantial inputs. They were constantly interacting over the telephone discussing their observations and outcome. This has resulted in recommending concrete solutions to challenges that we have faced during the project period.

I am thankful and indebted to hatchery managers, Suhas Toraskar of Vayangani, Shyamsunder Gavankar and Nandu Gavankar of Madban, Pradeep Dingankar and Rakesh Patil of Gaokhadi, Dattaram Vanarkar and Prathamesh Khot of Dabhol, Pravin Todankar of Kolthare Dhopavkar mama and Rakesh Dhopavkar of Kelshi, for making phase III of this project a success. Their positive attitude and constructive efforts in hatchery management will be a valuable addition to the successful conservation of sea turtles in Maharashtra.

I appreciate the voluntary involvement of Shri Yogesh Anavkar from Kelshi for his pro-active role in collecting scientific evidence, disseminating information to the beach manager. Pradeep Dingankar, Rakesh Dhopavkar, Suhas Toraskar and Pravin Todankar needs special mention as they have applied the scientific knowledge gained from the previous year project in overcoming the adverse situations that arose during the project this year. I am thankful to all these dedicated people and wish they continue with their work with the same zest. I appreciate the efforts of Shri Kishor Jambhekar of SYSLAB automation Pvt ltd in providing technical service as and when required.

I sincerely thank DFO Ratnagiri Shri Deepak Khade Sir and RFO Dapoli Shri Vaibhav Borate sir for their kind cooperation and patience. Due to their firm support, I could courageously face some difficult situations. My work does not end without a mention of Shri Sunil Limaye Sir (as APCCF WL) who was rock-solid support during my research work and was always approachable.

I am also thankful to other officials of the Maharashtra Forest Department. Lastly, I would like to thank the PCCF (WL) of the Maharashtra State Forest Department for permitting me to work on Schedule I species

Ms Sumedha Korgaonkar (4th Dec 2021)

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Introduction:

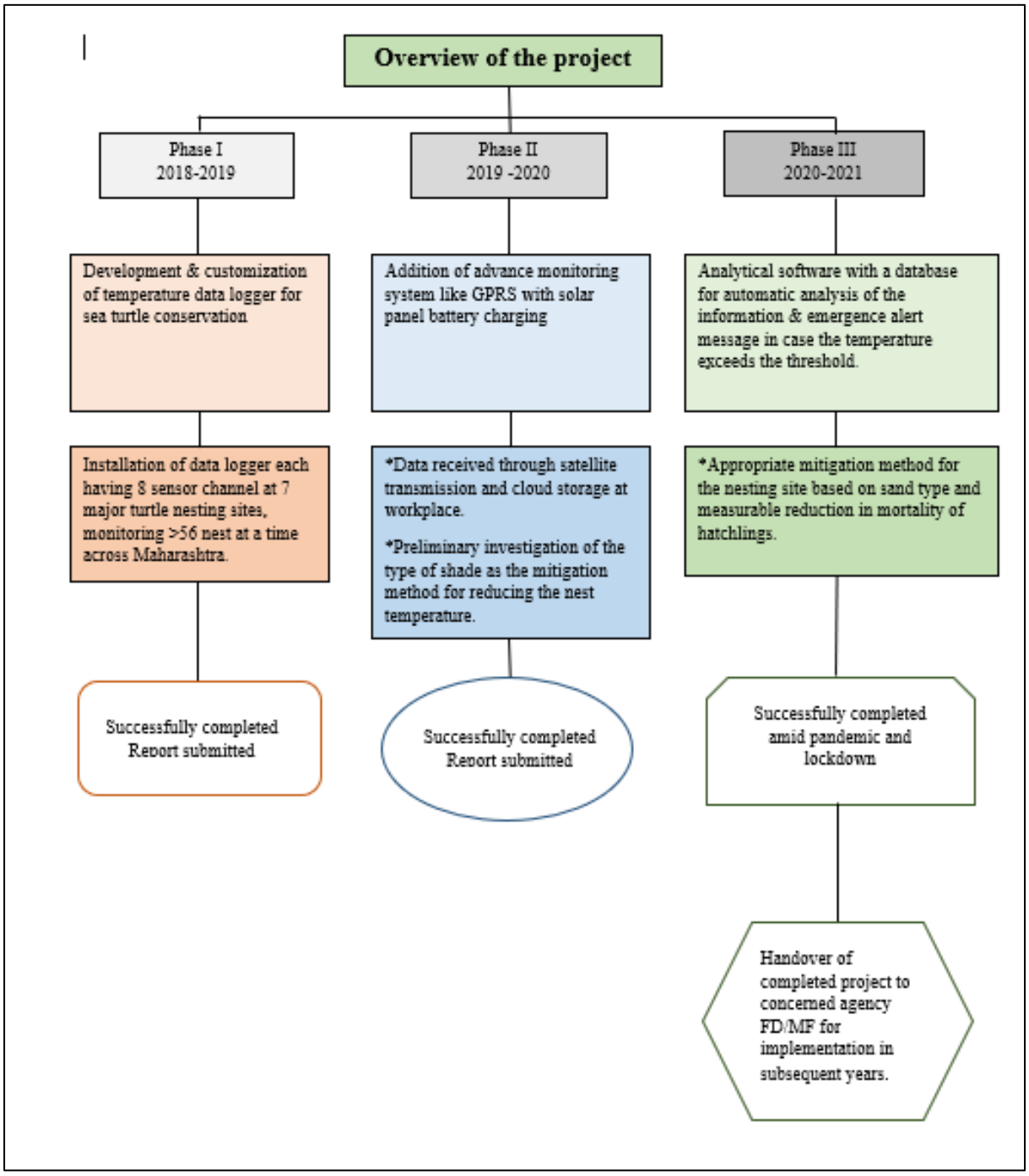
Globally, the Indian Ocean west is considered a putative Regional Managing Unit (RMU) for the conservation of olive ridley turtle and necessitates research (Wallace et al., 2010). The regional population of circum-tropically distributed olive ridley turtles occupies distinct ecological roles in defined RMU attracting conservation efforts. Maharashtra on the west coast of India, a part of this unit harbours an important nesting site for this distinct population of solitary nesters.

As a research priority, there is a need for identifying the preferred nesting site and factors that maximize hatching success. Nest's environmental conditions affecting sea turtle embryonic development can vary between inter and intra nesting beaches. This difference is due to geographic location, weather, human interactions, and sand characteristics. Like other reptiles, the sex of the hatchling is temperature-dependent. Generally, lower incubation temperatures (25°C -28°C) produce males while higher temperatures (30°C -32°C) produce females but could vary among populations. Nest temperature plays a pivotal role in embryonic development, the sex ratio of the population, hatching and emergence success rate. Increased temperatures as a result of climate change or late nesting extending to summers would not only alter sex ratios of the population but also decrease hatching and emergence success (Laloë et al., 2017). Lethal nest temperatures during the pre-emergent period could compromise the successful emergence of hatchlings by inhibiting coordinated movement and in extreme cases can cause spasms (Rings et al., 2015).

Sea turtle beach hatcheries existing as an ex-situ conservation management is a common practice in Maharashtra. The average four years nesting data of forest departments from various nesting sites suggest >50% hatching success rate. To assess the effect of temperature on hatching success and effectively implement a mitigation method with a continuous temperature monitoring system has been developed and customized.

The objective of the phase II project is as follows:

1. To install the temperature data logger with advanced GSM hardware and solar panels.
2. To implement an appropriate shade required as per the sand type for maintaining the nest temperature under a threshold temperature of 33^0C.
3. Developing an open-source analytical software and a database.



Studying the incubation temperature of a nesting population of olive ridley turtles (*Lepidochelys olivacea*) in the coast of Maharashtra with advance data logging system (Phase III) – Submitted by Sumedha Korgaonkar (Nov 2021).

Activity Timeline: Phase III

Sr.no	Activity	Proposed time period	Actual time period
1.	Temperature data logger installation on the field. Initiating collaborative work with College of Engineering, Pune (CoEP) for analytical software.	Feb 2021	Feb 2021
2.	Study of types of shade used in the hatchery	Feb end – mid-March	Feb end – mid-March
3.	Implementation of methods to maintain nest temperature below the threshold temperature. Examination of the nest post-hatching for mortality of unhatched eggs.	March, April, May	March, April, May
4.	Data analysis and final report submission	May 2021 - October 2021	May 2021 - November 2021

Development of analytical software through CoEP was initiated in Feb 2021 with multiple meetings with concerned staff and the head of the Computer Science department. Due to some unavoidable circumstances, they could not provide the blueprint of the software and finally withdraw the collaboration in May.

Compilation of activities with its outcome from field sites: Phase III

	Kelshi	Anjarla	Kolthare	Dabhol	Gaokhadi	Madban	Vayangani
Datalogger working throughout the project period	Y	Y	Y	Y	Y	Y	Y
Technical difficulties	Y	N	N	Y	N	Y	N
Technical difficulties addressed by the vendor during project period	Y	Not required	Not required	Y	Not required	Y	Not required
Data saved in memory card	N	Y	Y	N	Y	N	Y
Data transferred through Sim card	N	Y	Y	N	Y	N	Y
Mobile Network	No	strong	strong	strong	strong	No	strong
Damage to datalogger	N	N	Y	N	N	N	N
Temperature data observed by hatchery manager	Y	Don't know	Y	Y	Y	Y	Y
Shade provided on hatchery	Y	Y	Y	Y	Y	Y	Y
Additional mitigation efforts taken by hatchery managers to reduce temperature	Y (Sprinkling water)	Don't know	N	N	Y (Hatchery in casuarina plantation)	N	N
Other difficulties during project	N	Don't know	Predatory ant attack, Ipomea roots invasion, Jackal predation	N	N	Sea water flooding	Sea water flooding and predatory ant attack
Nesting data provided by hatchery managers	Y	N	Y	Y	Y	Y	Y

Part A - Scientific Evidence of Project

A1a] Installation of Datalogger:

All seven data loggers were installed with an advanced GSM system before February 2021. Each data logger is equipped with a SIM card that sends data to paid cloud service once a day. The data loggers were installed at Kelshi, Anjarla, Kolthare, Dabhol, Gaokhadi and Madban in Ratnagiri district and Vayangani in Sindhudurg district. The installation was done by Ms Sumedha with the help of respective hatchery managers.

Fig1: Temperature datalogger installation at project site A) Dabhol B) Gaokhadi C) Kolthare D) Vayangani E) Kelshi F) Madban
PC: Sumedha Korgaonkar and Prasad Gond

A1b] Working of data logger on the field:

The temperature data was received regularly from Gaokhadi, Anjarla, Kolthare and Vayangani sites. Madban there was a weak network so the data received was intermittent. Kelshi did not have a network on the installed site so no data was received. All the dataloggers displayed readings and were working.

<u>Problems</u>:

The major technical difficulty observed in phase III is data was not recorded on SD cards in Kelshi and Madban sites resulting in its loss. Immediately after the installation at Kelshi, Madban and Dabhol site the datalogger malfunctioned. The main datalogger was removed by Ms Sumedha and sent to the vendor for repair through speed post. Damage to hardware, sensors due to the corrosive action of air was not observed even after 3 years of its use on the nesting site. The humidity and water-resistant protective casing of the IP 65 box embedding the data logger have proved to be effective.

Reasoning:

The most likely reason for the malfunctioning of the datalogger is damage to the instrument during transport to the sites for installation. The dataloggers were serviced at the last hour and were installed without checking it's working.

Suggestions:

*Dataloggers should be kept ready for use in Dec.

*Before installing on the field site, the functioning of the dataloggers should be checked with sim card and receiving of data.

*Dataloggers should be placed in a big container box during transportation.

*Sites where there is a weak network the hatchery manager should note temperature data at least once a day at a fixed time. This will prevent the loss of data.

A1c] Data collection:

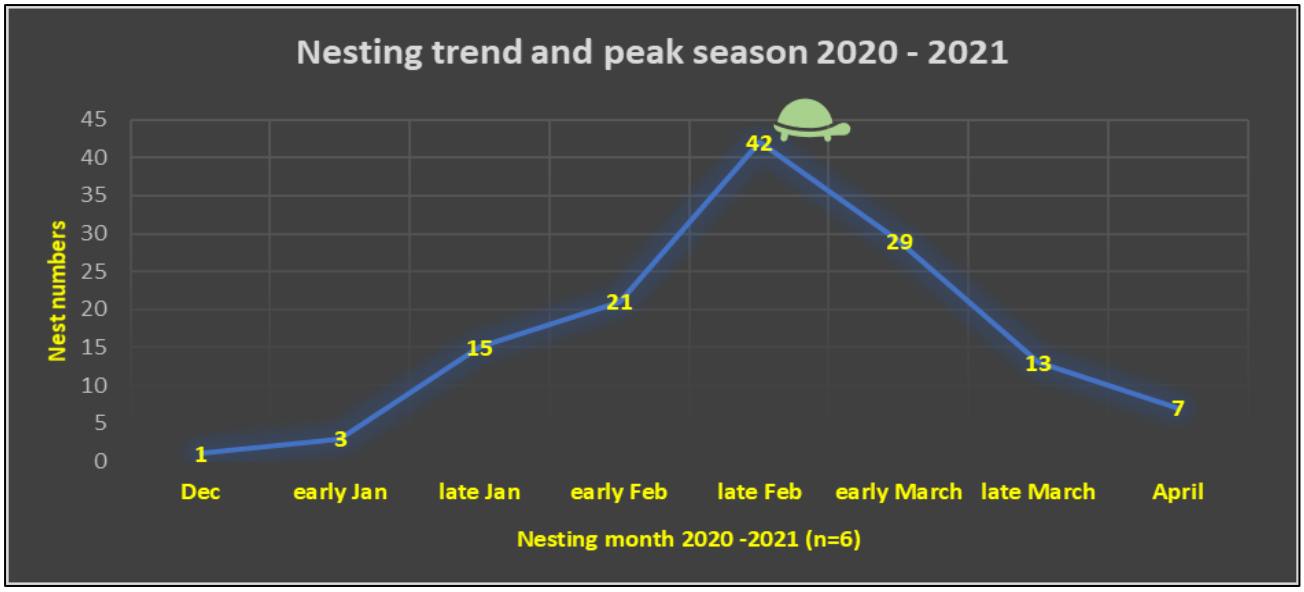
The beach managers were instructed about the installation and use of the data logger. As in previous years, sensors replaced the sticks that were kept in the relocated nest. Nesting data, any queries and relevant information were shared regularly in the WhatsApp group. The temperature data was retrieved off-field by Ms Sumedha Korgaonkar.

A2] Compilation of nesting pattern, emergence success, incubation pattern and mitigation efforts:

A2a] Nesting pattern and peak season: *Peak nesting season is that period when a maximum number of nests are found. It can last for a few days or can be long over a month.*

Nesting site	Nesting month 2020 -2021							
	Dec	early Jan	late Jan	early Feb	late Feb	early March	late March	April
Kelshi	0	0	1	2	8	6	3	0
Anjarla	Data not provided by hatchery manager							
Kolthare	0	2	0	2	12	10	5	4
Dabhol	0	0	6	3	5	4	0	2
Gaokhadi	0	0	3	1	3	3	1	1
Madban	1	0	0	3	2	0	0	0
Vayangani	0	1	5	10	12	6	4	0
Total nest	1	3	15	21	42	29	13	7

Table 1: The nesting data of the study sites. Early represents from 1st to 14th day of the month and late is 15th to 30th day of the month



Graph 1: Combined nesting data of six study sites showing the nesting trend. Most of these sites are major nesting sites representing the nesting trend and peak season in Maharashtra.

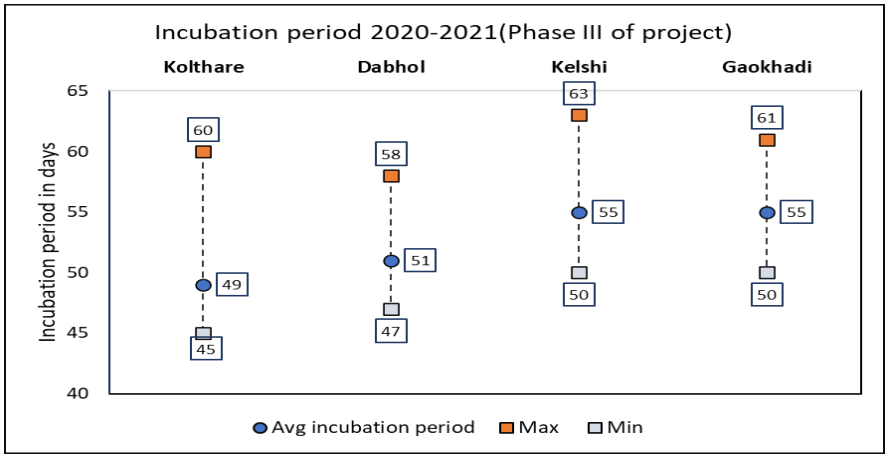
Like the previous year (2019- 2020) this year, the nesting season started in January with a gradual increase in late January and early February. The peak season is observed in late February ie from 15th February till 28th Feb and gradually waned till 15th March. A significant number of nests are seen in late March and April (Graph 1).

The nesting trends deducted from three years of this project point out with confidence a massive shift in peak nesting season late February resulting in an incubation period spread throughout the harsh summer months.

As the global temperature is increasing a more shift of peak nesting in early March is a possibility in subsequent years.

A2b] Incubation period:

The incubation period is the number of days from egg-laying to the emergence of hatchlings inside the nest.



	% emergence
Kelshi	56.4%
Kolthare	18.6%
Dabhol	40.0%
Gaokhadi	59.6%

Graph 2: A comparison of the incubation period of the nesting sites. The minimum period was observed in the nest which was incubated during April.
Table 2: Percentage emergence success rate in project sites. Temperature is not the only factor in the low emergence % of Kolthare, predatory ant attack, invasion of Ipomea and Jackal predation were equally significant.

The incubation period of Kelshi and Gaokhadi was above 50 days throughout the nesting season of 2021 (Graph 2). Correspondingly the emergence % is above 55%. Apart from shade net installed over the hatchery additional efforts were taken to keep the incubation temperature below the threshold temperature of 33ºC.

The incubation period is inversely proportional to temperature. More the temperature less will be the incubation period. Though the incubation temperature of Kelshi was not recorded it is evident from the incubation period that the temperature would be under control during April month.

Also, the greater the incubation period the hatchlings tend to be larger, active in the movement and less malformed thus increasing their chances of emergence and survival success.

A2c] Position of the hatchery on the nesting site.

The hatchery location on the beach is very important in terms of the incubation temperature of the nest which in turn impact the outcome i.e Emergence success %. This results in the variation of results among the nesting sites (Table 3).

The generalization about the outcome based on observations of one or two nesting sites cannot represent the outcome for Maharashtra. Such generalization should be avoided.

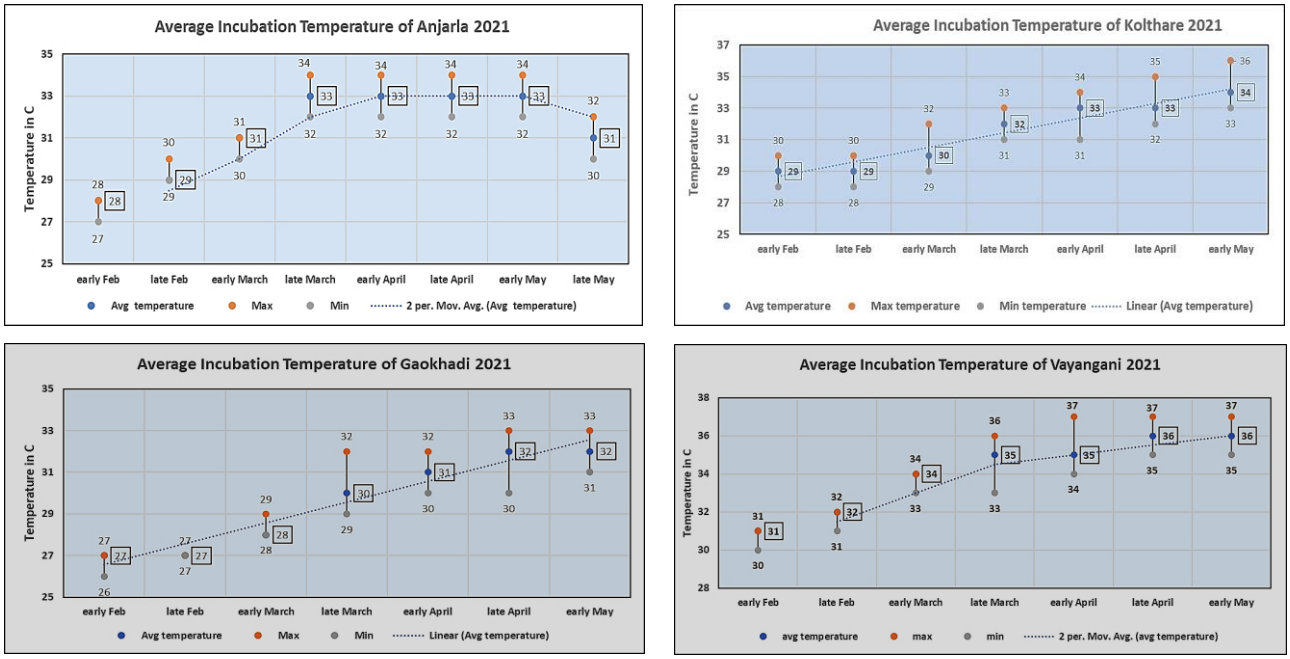
Hatchery position on the beach				
Nesting sites	On Beach (Seaward side)	on Beach (estuary side)	On Dune	Casuarina plantation
Kelshi	Y			
Anjarla			Y	
Kolthare	Y			
Dabhol	Y			
Gaokhadi				Y
Madban		Y		
Vayangani	Y			

Table 3: Hatchery position on study sites having variations in the micro environment surrounding the nest.

Kelshi and Vayangani hatchery receives direct sunlight from early morning till sunset. Anjarla the hatchery is built near the coconut plantation above the beach dune. It also receives direct sunlight from 10 in the morning till sunset. Kolthare the hatchery was at the base of the dune having vegetation of Ipomea, Pandanus and Coconut plantation. Dabhol beach is at the mouth of a big estuary. The soft sand is present towards the estuary side but there is no space to build a hatchery due to the dense casuarina plantation. The sea ward side of the beach is silty and muddy. A small sandy patch is available for the hatchery. The two sides of the hatchery are covered by a tall casuarina plantation hence it receives direct sunlight after 11 am till sunset. At Gaokhadi the hatchery was erected among sparse casuarina plantations receiving direct but less intense sunlight. Madban is affected by high tidal water and the seaward beach gets submerged completely during high tide. So, the hatchery was constructed on the estuary side of the beach which is cool and receives less intense sunlight. This year unexpectedly it got flooded with sea water during high tide. Vayangani the nests are kept on the beach which receives direct and intense sunlight from sunrise to sunset. Though the beach is broad there is an increased incidence of unpredictable flooding during spring high tide.

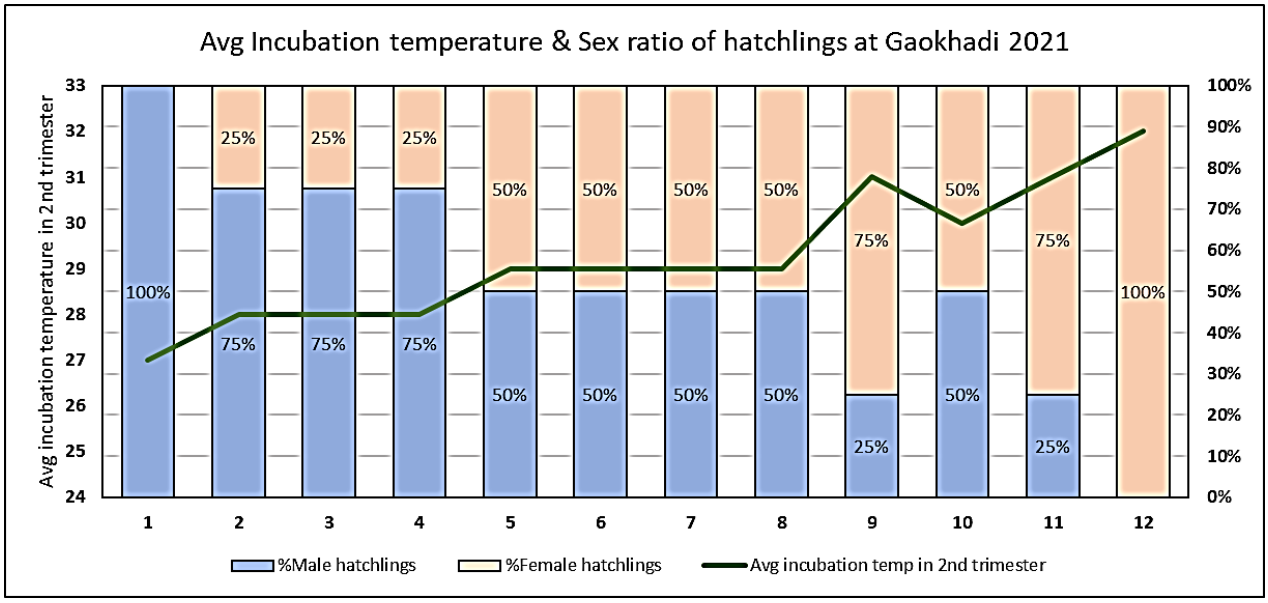
A2d] Incubation temperature of the nest from study sites: *Incubation temperature is the temperature of the nest throughout the incubation period. The heat released during the development and growth of the clutch contributes to the incubation temperature. The effect of external ambient temperature on incubation temperature is dependent on the depth of the nest. A shallow nest shows*

the influence of external temperature than a deeper nest. Olive ridley nests are shallow so exterior heat also affects the nest incubation temperature along with incubation heat.



Graph 3: The average nest temperature data from the datalogger of four project sites across the nesting season. The avg incubation temperature of the sites is the average temperature of all the nests irrespective of their developmental stage. The max incubation temperature represents avg temperature of some nests showing higher values similarly the min temperature shows the avg incubation temperature of some nests showing lower incubation temperature. This is due to differences in the developmental stages. The incubation temperature of the nest increases during the growth stage.

The avg incubation temperature of Anjarla was well within the threshold limit reaching the maximum incubation temperature of some nest to 34ºC from late March to early May. Nesting data was not provided so no correlations could be made between emergence success and incubation temperature. At Kolthare the incubation temperature showed a steady increase reaching a maximum of 36ºC in early May. Due to other threats like ant and jackal predation and Ipomoea root invasion the emergence data cannot be correlated to temperature data. Vayangani nesting site showed relatively higher temperatures throughout the nesting season. The maximum average temperature of the nest has even touched 37ºC. The infestation of predatory ants has interfered with the temperature-related mortality of the nest hence the temperature data could not be correlated. The average incubation of the nest throughout the nesting period at Gaokhadi shows an ideal incubation temperature of 32ºC with a maximum avg temperature of some nests reaching 33ºC (below the threshold temperature) (Graph3). The emergence success, sex ratio and avg incubation temperature are correlated.



Graph 4: Graph showing the well-balanced sex ratio of the hatchlings at Gaokhadi.

The nesting season in Gaokhadi started in late January and ended in late May. From late February till April end 8 nests (out of 12) were found in Gaokhadi (Graph 4). These nests had their incubation period in March and April when the ambient temperature is high. The cooling effect of the plantation had affected the incubation temperature resulting in a higher emergence rate. An observable benefit of erecting hatchery inside sparse casuarina plantation is a well-balanced sex ratio of hatchlings estimated by indirect temperature method which considers the avg incubation temperature in the 2nd trimester.

A3] Mitigation to keep the incubation temperature under threshold value of 33ºC:

Except for Gaokhadi and Vayangani, all other sites Kelshi, Kolthare, Dabhol, Madban used a green shade net provided by the Forest department (Fig 2). The outcome of phase II of this project has shown the inefficiency of the green shade net solely in reducing the nest incubation temperature.

Kelshi: The hatchery manager Shri Rakesh Dhopavkar with the help of readings in the datalogger did an additional method of reducing the nest temperature. The nest which showed aggravated temperature i.e., above 34ºC, sprinkled water on the side of the nest (and not on the mouth of the nest). At least 1 mug (250ml) of water was sprinkled per nest once a day at noon when the temperature

is high. This helped reduce the temperature of the nest also it did not accumulate the water in the nest. By the 4th day, the nest showed reduced temperature. He has done this throughout the incubation period. Evaporation of sprinkled water absorbs the heat from the nest resulting in lowering of nest incubation temperature

Fig2: Different shading method on hatchery. A) Gaokhadi hatchery inside casuarina plantation did not required shade due to moderate incubation temperature. B) shade over Dabhol hatchery C) Shade put over a meshwork of strong rope at Kelshi hatchery. In case of high temperature coconut tree leaves could be kept over the shade. This will also provide cool ambient exterior temperature. D) Covering of the hatchery with green shade net at Kelshi. Use of just the shade net over hatchery is not enough for mitigation of high incubation temperature.

The emergence % of Kelshi this year was 56.40% as against the previous year (2019-20) emergence rate of 25% (Table 2). Increased emergence rate is due to improved handling practice and keeping the temperature under the threshold of lethal temperature ie 34ºC

Gaokhadi: Due to heavy beach erosion and rise of sea level till the dune vegetation compelled the hatchery managers to erect the hatchery in casuarina plantation. The method of hatchery construction is as described by Pradeep Dingankar. The place inside the plantation was selected based on sand quality, sunlight availability and density of trees. The place was sparsely dense with plants, the sunlight coming to the hatchery though direct was not intense and the sand was soft without mud. The sand was loosened up to a depth of 2 feet inside the hatchery to check the absence of mud. Roots of wild shrubs and grass were removed while digging inside the hatchery (Fig 17 *annexure*)

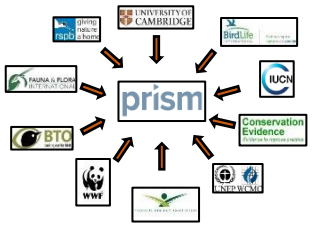
The temperature was checked daily in the datalogger by hatchery managers. No shed net was used above the hatchery throughout the incubation period. The avg incubation period of Gaokhadi this year was 55 days with an emergence success rate of 59.6%. Th hatchlings emerged out of the nest of their own as contrary to previous years which required rescuing the trapped hatchling.

The low threshold temperature resulted in the release of less incubation moisture, which in turn, resulted in no hardening of the sand. The hatchlings were not trapped and emerged naturally. Additionally, the plantation provided a cooling effect thus reducing the ambient temperature outside the nest. No extra efforts were required to reduce the incubation temperature of the nest.

Part B - Evaluation framework of the Project

Evaluation source:

PRISM is a toolkit developed by a collaboration of international conservation organizations to help support conservationists to evaluate the outcomes and impacts of their work. Short term conservation projects often have the measurable impact visible many years after the project ends. This toolkit with its evaluation of outcome and impacts helps to overcome this challenge.



Source: www.conservationevaluation.org

Purpose of the evaluation: The short-term project aims to achieve a long-term conservation impact in mitigating the effect of high nest temperature due to the gradual shift of nesting season from winter to the summer season.

The outcome of the evaluation :

The objectives of phase III of the project were mostly completed amid pandemic and lockdown. As previous year the strong role played by hatchery managers in collecting appropriate data during lockdown has shown their importance for this project as a Para biologist. In general, the hatchery managers of all the nesting sites are the real executioners of the conservation management work.

The temperature data logger instrument customized for hatchery on the beach was found to be technically robust in its functioning. Few technical issues of data transfer, weak network though identified during the project were seen even this year. It needs permanent rectification from the vendor. The PRISM toolkit has helped evaluation of the project pointing to finer details in phase II of the project which helped in the execution of phase III. The method of evaluation of the nest post-incubation period needs implementation on-field through advanced training to the hatchery managers. The mitigation of nest temperature by using appropriate methods was executed with a clear outcome. It needs to be implemented in subsequent years.

The project was successful in achieving its long-term conservation goal of mitigation of high incubation temperature to increase the emergence success rate. It has taken the conservation management of sea turtles in Maharashtra to an advanced level beyond the usual protection and release of hatchlings. The Maharashtra State Forest Department is now ready to overcome the challenges of climate change in olive ridley turtle conservation through this project.

Problems during the project period: a peculiar case of Kolthare and Vayangani

During the project period on two study sites viz Kolthare and Vayangani other threats were observed. The impact of the threats was severe. Though the management was not part of this project it requires the attention of the Mangrove cell/foundation for implementation of corrective action in the coming nesting season (2022).

Kolthare: Kolthare had 3 major problems:

Problem 1: Predation of turtle nest by golden jackal – A separate project under the grants of the Society for Conservation Biology (SCB) marine was executed by me on Kolthare beach for 2.5 months. The nesting site was severely affected by jackal predation since 2018. The relocated nest counts to 36 at Kolthare this year. In addition to this, 13 nests were completely predated by jackals. We have to stop the project because of lockdown in mid-April. Under the project, we had set up a trail camera on the beach to assess the number of jackals and to study their foraging behaviour on the beach (Fig 3). The trap camera data has identified 4 jackals active at night irrespective of the presence or absence of hatchery managers. The jackals are present on most of the nesting beaches. But on Kolthare we observed that they had become a severe threat feeding voraciously on turtle eggs. They devour all the eggs of the nest. We got to know from locals that there was severe predation of eggs in the 2019-20 nesting season during the lockdown. This changed behaviour was due to the high frequency of nesting and a smaller number of patrolling people on the beach.

We observed in our study that in the case of more than one nest the jackals dug up the nest and relocate the eggs to another site for later consumption. We found the hidden eggs on the beach. Relocation or killing of Jackals will not solve the problem as they will be replaced by other ones. There is a forest around Kolthare and a high jackal population. Even continuous patrolling at night by 2 hatchery managers will not solve the matter as the jackals are constantly observing the hatchery managers. It is dangerous for just 2 hatchery managers to patrol at night in presence of a pack of Jackals. The hatchery managers have to do their jobs in the daytime and continuous patrolling throughout the night for 3 months is not feasible for them. On Kolthare I have observed 4 – 5 females coming at a time to nest. Many a time the nesting is happening simultaneously at the two ends of the beach. It becomes difficult for two hatchery managers to keep a watch on the jackals and do the relocation work. In our presence, we have observed jackals predating on the nest at a distance of just 50 m. During such time I have observed the whole family (parents, brother, wife) & friends of hatchery manager Pravin Todankar on the beach guarding the nest against jackals. Though we came

up with promising results with our study we need to do further study to establish our research hypothesis. RFO Dapoli Shri Vaibhav Borate sir was regularly informed during the project work.

Solution: For the 2021-22 nesting season we propose another alternative, in addition to 2 hatchery managers 6 extra young men should be appointed by the forest department for patrolling at night on Kolthare beach. The appointment should be done from mid -January, February till March. The patrolling will be done in shifts 9.00 pm – 1.30 am and 1.30 am – 6.00 am. At a time 4 people will be patrolling the beach at night. This will not put physical pressure on regular hatchery managers and will be convenient for forest officials. If properly executed this will help in reducing the predation

Fig 3: Predation of nest protected inside the hatchery by Jackals at Kolthare and the corresponding efforts to study their behavior and reduce predation. **A)** relocated nest predated by Jackal inside the hatchery (early feb 2021). Hatchery was made strong by using steel wire net donated by Shri Sachin Joshi. The entrance to the hatchery was secured to prevent jackals from entering the hatchery. **B)** A trench was dug up and dry coconut leaves were added. Through trap camera we found that Jackals were trying to enter the hatchery by digging below the net, so this was done. It prevented Jackals from digging below the net (trap camera video). **C)** various methods were tried to scare the jackals and keep them away from beach. One such is scarecrow with light and audio system which kept the jackals away from hatchery site. It is a promising method but needs more research to assess its effectiveness. **D)** Nest predation on beach. All eggs are devoured **E&F)** Trap cameras installed throughout the beach to study jackal predatory behavior and their response towards preventive techniques. The project was executed over a period of 2.5 months.

PC: Sumedha Korgaonkar and Prasad Gond.

Problem 2: <u>Growth of Ipomoea roots inside the hatchery covering the eggs:</u>

The presence of roots was detected when no hatchlings emerged from 1st nest. After 60 days, the top sand of the nest was removed to check the presence of hatchlings. There were no hatchlings but instead roots surrounding the eggs were seen (Fig 4). The examination of eggs after excavation showed that all the hatchlings were dead inside the eggs. The dead hatchlings were completely developed and were in the growth phase (Fig 4). To stop further spread of roots inside the hatchery. A trench was dug up on the outer three sides of the hatchery. The roots were removed completely. The trench with broken roots was kept exposed to sunlight for 4 days. Direct exposure to sunlight kills the root and stops their growth. After 4 days an Aluminum sheet was placed in the trench. It prevented the invasion of roots from outside to the inside of the hatchery. While digging the hatchery compost was seen under the sand. The previous year the hatchery place has got cleared of pandanus during the Nisarga cyclone. The pandanus roots have turned into a compost below the sand. The hatchery manager Kedar Todankar did not realize this before erecting the hatchery. There must have been the seeds of Ipomoea embedded in the compost which gave rise to a network of a root inside the hatchery. Even after one month of managing the entry of roots from outside the hatchery, a dense network of roots was seen on the eggs and encircling the mouth of another nest inside the hatchery (Fig 5). This was the situation was critical and management for roots was done along with management of ants (Fig 6).

Solution: In case of severe root invasion, the hatchery manager can relocate the nest to another site. For that, a new place should be selected and a hatchery erected on it. A pit of the depth of nest viz 1.5 feet should be dug. The eggs should be excavated from the invaded hatchery and immediately shifted to the new hatchery. Handling of eggs is very important during relocation. The stage of the incubation should be considered before shifting the eggs. The eggs of the nest on the 25th day of incubation can be successfully relocated since the hatchling has grown bigger than the yolk. Still, as a safe practice, the eggs should not be rotated while excavating from an old nest or transferring to a new nest. The transferring should be done in daylight at an early hour before 7.30 – 8.00 am when the ambient external temperature is almost equivalent to the nest incubation temperature. The transferring requires patience, a calm mind and a stable hand to transfer the eggs from one site to another (see Vayangani problem).

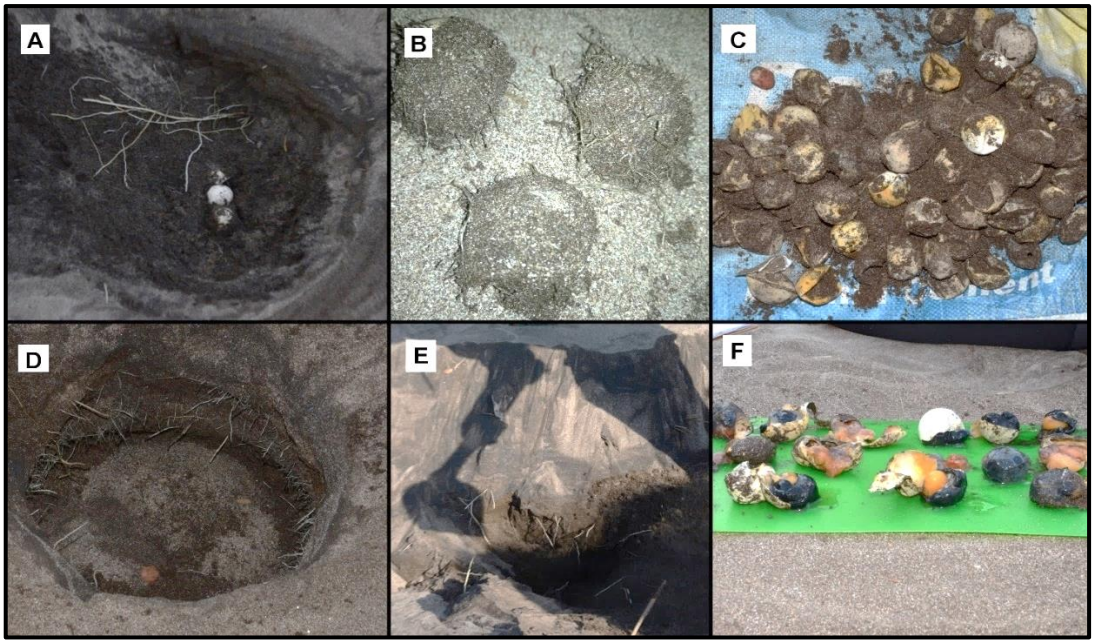


Fig 4: The 1st nest of Kolthare failed to emerge even after the incubation period of 65 days. Ipomea roots were found inside the nest and on the eggs. The developmental stage at mortality was assessed to ascertain the cause of death. A) Main tap root over the nest B) roots hairs with sand over the eggs C) nest was emptied and eggs excavated D) Roots saw forming the strong network at the mouth of nest E) while finding the roots entering the hatchery from outside, fine compost was found below the sand. The compost was formed after the Nisarga cyclone (2020), which cleared the pandanus plantation on this site. The severe invasion of Ipomea despite its removal at the time of building hatchery was due to this compost. F) Developed but dead hatchlings. PC: Sumedha Korgaonkar & Prasad Gond.

Fig 5: After the roots were found inside the hatchery, immediate remedial actions were taken to remove the roots and prevent further growth. A) Roots entries were found by digging outside the hatchery on all three sides. B) A deep trench was dug outside the hatchery. C) The roots were kept exposed to sunlight for 4 days. This is the method to kill the roots E&F) Aluminum sheets used for roofing were cut into strips. It was kept in the trench which was then covered up with sand. The aluminium sheets form a barrier and prevent the entry of roots from the exterior. PC: Sumedha Korgaonkar and Prasad Gond.

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Fig 6: Profuse growth of roots inside Kolthare hatchery after corrective action of removal of root outside the hatchery. It affected all the subsequent nests. The roots were seen along with predatory ants. Their occurrence together is unrelated. A) roots over the nest having predator ants B) As remedial action sand beside the nest was dug out without disturbing the nest. It can be done on nesting sites where the sand is moist and compact. C) The treatment of neem powder against predatory ants is, unfortunately, manure for roots. To stop the further growth of roots in the nest a barrier of flex strip was used. The flex did not allow the roots to grow in the nest having neem powder against ants. This method proved to be beneficial as hatchlings emerged from the nest successfully. PC: Sumedha Korgaonkar

Problem 3: <u>Red blind predatory ant attack</u>

The third severe problem faced at Kolthare along with jackal and Ipomoea roots was an attack of *D orientalis* locally called 'Chachad'. These are blind subterranean ants that are known pests on potato and groundnut (see preprint). A study was initiated by the mangrove foundation in Vayangani regarding the management of these ants. This year for the first time the ants were seen attacking the eggs on Kolthare beach. Ipomea roots and predatory ants at the same time was a fight or flight situation. RFO Vaibhav Borate sir, DFO Deepak Khade sir and ACCF (WL) Sunil Limaye sir were immediately informed of the situation. The grave situation was partly because of hatchery manager Kedar Todankar who had become an alcoholic in past few years. He did not allow the other hatchery manager Pravin Todankar to work on the

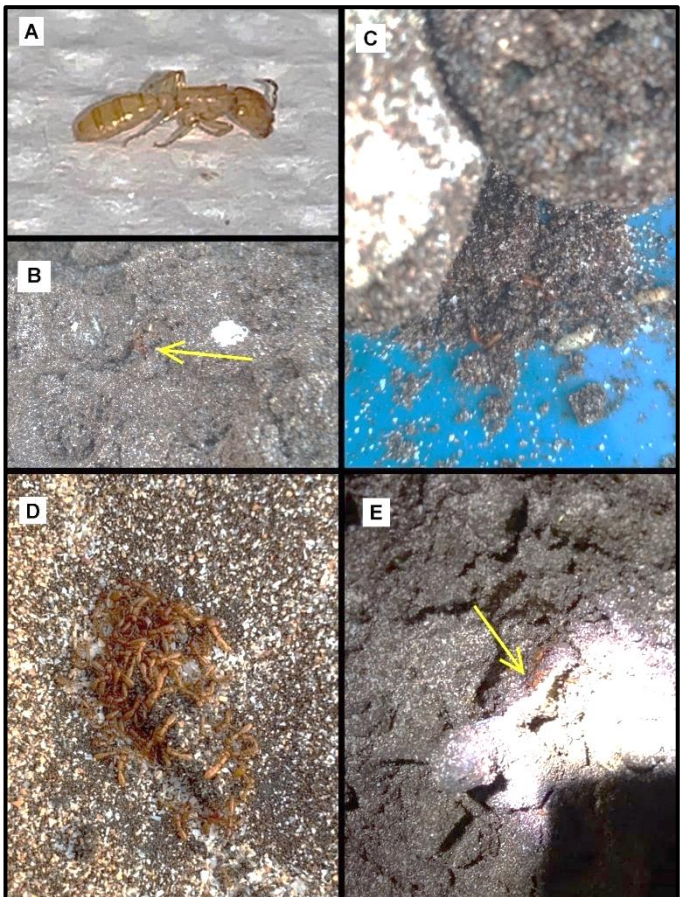

Fig 7: Predatory red ant (*D orientalis*) invasion for the first time at Kolthare. **A)** *D orientalis* **B)** Ants seen on the nest **C)** turtle eggs punctured with holes by ants **D)** live hatchling covered by ant **E)** emerging hatchling attacked by ant.
PC: Sumedha Korgaonkar, Pravin Todankar, Prasad Gond.

beach at the start of nesting season. Kedar sublet the work to his other alcoholic friends who were not experienced. Relocation of the initial nest was shoddy. The subletting stopped after our intervention and he allowed Pravin to do the work. After all these problems when I confronted him, he threatened me and made a huge tamasha in an inebriated state. I have to involve Sunil Limaye sir in this matter and on the advice of Khade sir approached Dabhol police station for protection. An official complaint was given to Khade sir after which he was removed from the job. After all this event management of ants and roots was a huge challenge for us. Me and Pravin Todankar decided to save the nest by using neem seed extract on the nest. It was done on an experimental basis with no guarantee of its success. A written declaration was submitted to Khade sir and Limaye sir with details of work.

Fig 8: Remedial action against ants and Ipomoea roots. **A)** Neem cake made from the residue of neem seeds was more powerful than neem powder made from dry leaves and bark. This was procured from a nursery in Dapoli. **B)** The neem cake also acts as manure. With the presence of Ipomoea roots, a barrier of flex strip was used between eggs and roots. **C)** Neem cake mixed with nest sand was added near the nest to prevent ants. **D)** The nest was closed with nest sand. **E)** where there was the severe presence of ants the nest was excavated. Eggs were carefully removed and neem cake treatment was given. The eggs were carefully placed back in the nest. The procedure was done early in the morning till 7.30 am. The ambient temperature and nest temperature was considered before doing the work. The remedial actions proved successful in saving the hatchling from predatory ant and Ipomea roots.

The treatment work was done with prior experience on Vayangani beach under the responsibility of Sumedha Korgaonkar.

PC: Sumedha Korgaonkar

Management of ants and roots: there are two types of neem powder in the market used for gardening purposes. One is made of dry leaves and bark and another one is the powder that remains after the extraction of oil from the seeds. The latter is more effective against *D orientalis* than the first. It was known from the work done at Vayangani beach this year. This powder is also used as organic fertilizer. It has a dual purpose in the garden. In our case, it will stop the ants from attacking the developing hatchlings but at the same time, it might provide nutrition to the roots. After getting nutrition from the neem the roots may grow extensively or remain restricted which was not known. So, we dug around the nest without disturbing the eggs. Short strips of flex banner were used to restrict the roots and neem powder was spread surrounding the nest (Fig 8). This we did from nest 3 – 16 in the hatchery. Nest 16 onwards roots were not seen so only neem powder was added around the nest. Extra sand was removed from the hatchery and the sand was levelled. Though in low number hatchlings hatched inside the nest. After the incubation period of 50 days, we carefully removed the top sand of the nest to see the hatchlings. Trapped hatchlings were rescued from the nest and released. Hatchlings till nest 27 were successfully released. The remaining nest were lost to the Tauktae cyclone.

Solution: Kolthare is the best rookery site of olive ridley turtles in Maharashtra. Every year more than 50 nests are found on the beach. A high number is because of the quality of sand, absence of humans on the beach. Due to these problems which are persistent for 3 years, it showed the worst results. It needs more attention from the forest department in terms of support and law enforcement. A hatchery made of part bricks and a part net is recommended. The bricks will go at least 3 feet inside and 3 feet above the sand. Above the brick, a steel net enclosure can be erected. The brick wall inside the sand will not allow roots and predatory ants to invade inside the hatchery. The steel net will protect the nest and hatchlings from Jackals.

Vayangani (Vengurla):

The problem with Vayangani beach is many people are searching for a nest at night for money. The Forest department has allowed anyone to find the nest. There are two people separately doing relocation and protection. Suhas Toraskar among this two is skilled and highly experienced. He guards the nest the whole night as the relocated nest gets stolen. The 2.5 km beach is divided based on different wadi. There is a sort of competition between Dabholiwadi residents and Bagayatwadi residents of Vayangani beach to find the nest. Many people are seen moving on the beach with torchlight. This has resulted in many turtles abandoning the nesting beach due to human disturbance. There is a small unhabituated beach adjoining the Vayangani beach. Suhas Toraskar has developed a good network on such a remote beach who excavate the eggs and give them to him for protection. He rewards them with money. He is not supported by the forest department as he has refused forest officials in showing increased nest number to siphon off money. No hatchery material is made available to him from the forest department. With experience and intelligence, he had developed handling and relocation skills which gives excellent results. Vayangani had a persistent problem ie of predatory ants. Though neem powder of dry leaves was used around the hatchery on 3 sides. The ants invaded through the fourth side. The 4th side remained untreated due to the unavailability of neem powder. At the start of nesting season, a 40 kg bag of neem powder was sent to hatchery manager Suhas Toraskar from Pune. It is not available in Kudal or Vengurla or Sawantwadi. After the ant attack, we did a lot of observation and changed our management technique. The ants if given choice do not attack freshly laid eggs but they prefer eggs with developed hatchlings. They were seen inside the nest with an incubation period of 40 days or more days. The ants attack the piped and emerging hatchlings. Suhas Toraskar with his exceptional handling skills transferred such nest to another location. Which had neem powder treatment. The nest which couldn't be relocated he dug up the eggs carefully, then added neem powder to it and then carefully placed the eggs inside the nest. All this has been video and photo-documented. The hatchling successfully emerged from the treated nest in good proportion. Predatory ants *D orientalis* is going to be a persistent problem in Vayangani and might be seen unexpectedly in other sites too. Along with this year, water flooded some of the nests. Many nests were saved with timely transfer to other sites(Fig 9).

Solution: The forest department should provide hatchery material to erect the hatchery. The Forest department should not allow more than two people to do relocation work on the same beach. Relocation of the nest should be done only by skilled people. If villagers are stopped from gathering the eggs, stealing the nest for money will stop. Strict action should be taken against those violating

the rules. People like Suhas Toraskar who does sincere work should be supported positively by the forest department and used as a resource person to spread awareness in the Sindhudurg district. Being a fisherman himself he has established a good network that informs him about the nest on other sites. In the Sindhudurg district, there are many small beaches where turtles come to lay eggs. Erection of hatchery is not feasible due to unavailability of interested person or location being remote. Relocation of such eggs to the hatchery site should be allowed.

Fig 9: Predatory red ants *Dorylus orientalis* is a persistent menace at Vayangani Vengurla beach. The treatment for the nest was given by Suhas Toraskar with his expertise. Neem cake was provided by Sumedha Korgaonkar. **A)** ants feeding on live hatchlings **B)** Neem cake procured from Dapoli nursery. **C)** neem cake with kerosene is potent for predatory ants. This could be used outside the hatchery at the time of its erection**. D)** Infected nest the eggs were excavated and treatment is given. **E)** Eggs carefully placed back in the nest **F)** neem cake sprinkled on the nest. **G)** Healthy hatchlings emerged from such a nest. They looked darker due to neem powder. **H)** Suhas Toraskar with the hatchlings emerged from the treated nest. The work was successfully done with his skilful expertise in handling the eggs and noting the scientific observations. PC: Sumedha Korgaonkar.

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Are we ready to face the challenges of cyclones during nesting season? - A case study of Gaokhadi

It's a known fact that the Arabian sea is going to have more and more cyclones which will make landfall on the west coast of India. Past two years we have seen the devastation of two cyclones Nisarga and Tauktae. This year's Tauktae cyclone hit the west coast during mid-May and in Maharashtra on 14th May 2021. Many nesting sites in Maharashtra were still having sea turtle nests. At project sites, Kolthare, Gaokhadi, Vayangani sea water flooded the hatchery resulting in water logging. Whereas at Dabhol sea water minimally washed the hatchery and there was no waterlogging. There were two nests at Dabhol in the advanced stage of development. The hatchery was completely covered by rain sheets by hatchery managers. 25% of hatchlings were released from the two nests post-cyclone. The hatchlings were trapped inside and were rescued by digging the nest after 50 days of the incubation period. At Kolthare there was no emergence from 27th to 36th nest even the hatchery got damaged (Fig 10). At Gaokhadi there was a single nest at an early stage of development. It was on the 27th day of incubation. The chance of survival of an early-stage nest is rare. There was a 100% possibility of sea water flooding the hatchery during the cyclone. Knowing my experience with relocation of the nest at mid incubation period Pradeep Dingankar of Gaokhadi approached me for saving the nest. We discussed the pros and cons before actually deciding on doing the relocation. On 14th when the cyclone made a landfall in the south at the nick of a time we decided to go ahead with the relocation of the nest. Pradeep Dingankar is a keen observer and knows the techniques very well. I was quite confident he could pull the work successfully. His associate Rakesh Patil has good handling skills. With available material, they decided to make a portable apparatus that will hold the nest. A broad PVC pipe of at least 1 feet diameter was used. It was placed on a mortar pan having sand. Eggs with sand were carefully placed in the set-up. Rotation of eggs was avoided during the transfer (Fig11). During the cyclone, the set-up was moved inside the makeshift hut protecting it from the rain. After the cyclone, the nest was regularly moved in sunlight for the whole day and then at night shifted inside the hut. From 14th May till 6th June utmost care was taken. On 6th June out of 120 eggs, 56 hatchlings emerged naturally from the nest. Though it looked like a crude experiment it was done with prior practical knowledge of transferring the mid incubation nest. RFO Rajendra Patil sir and Priyanka Lagad madam were informed by Pradeep Dingankar along with the photographs of the set up on 14th May.

A bigger concern is what will happen if in future the cyclone hits in April or the nesting season shifts more towards March. Are we ready to face the cyclones during nesting season? Can we do something to save the nest? If yes then what would be the set-up?

This work has paved the way for practically using an improvised technique that could be used to save the nest during the cyclone thus overcoming the threat.

Solution: looking at Dabhol and Gaokhadi cases the decision to save the nest during the cyclones depends

a) Where the cyclone is going to make landfall?
b) What would be the impact of the cyclone on nesting beaches owing to their geological position?
c) What is the intensity of the cyclone?
d) Is the hatchery safe from the seawater inundation?
e) What is the day of incubation of the nest?

There can be various approaches to implement

1) If the cyclone is of low intensity with rainfall but no inundation of seawater then covering the hatchery with plastic sheets tightly would be enough. Additionally, plastic sheets could be laid on the nest to prevent waterlogging of the nest by rainwater. A trench on the seaward side of the hatchery could be dug and a plastic sheet laid inside it stretching upwards halfway on the hatchery. The trench can be covered with sand. This will prevent seawater from entering the hatchery in case water rises (Fig 12).
2) In the case of medium intensity cyclone where the hatchery might get inundated. Then with proper protocol, the eggs could be transferred to a higher safer side of the beach where water does not rise. Another small hatchery could be erected where the nest would be kept well protected. The hatchery would be covered by plastic sheets similarly as described above.
3) In case if there is no place on the beach where the nest could be relocated. Non meshed large vegetable crates having a depth of at least 2.5 feet could be used to make a portable nest. Sand from the hatchery will be put in the crate and eggs relocated in the sand (Fig 12).
4) Alternatively, sand around the nest can be dug carefully without disturbing the eggs to the depth of 1.5 feet. A big plastic bucket with its base removed can be used as a cylindrical pipe. It will be inserted over the nest. The bucket can be covered with plastic sheets to prevent water from entering the nest (Fig 12).

Fig 10: Devastation of hatchery site by Tauktae cyclone that hit Maharashtra coast on 14th May 2021. **A)** Gaokhadi beach was severely eroded **B)** Casuarina trees felled on the hatchery. sea waves entered the hatchery. **C)** Kolthare hatchery was destroyed. Nest 27 -36 were flooded with sea waves. **D)** The watchtower at Gaokhadi before the cyclone **E)** The position of the watch tower at Gaokhadi after the cyclone. PC: Pradeep Dingankar & Pravin Todankar.

Fig11: An experimental set-up to save the turtle eggs from cyclonic rain was performed at Gaokhadi. The nest was on the 27th day of incubation. At this stage, the developing hatchling size is equal to the yolk size. There was no chance of it to survive the cyclone. **A)** a set-up is done by using locally available material. **B)** before the cyclonic rain the eggs were excavated skillfully from the nest. **C& D)** Eggs were placed in the pipe with sand taken from the nest. During the cyclone, the set-up was placed inside a makeshift hut protected from rain. After the cyclone, the set-up was carefully moved in sunlight during daytime and at night placed back in the hut. On 6th June the hatchlings emerged on their own from the nest with a 50% emergence rate. This work was executed by Pradeep Dingankar and Rakesh Patil of Gaokhadi and was successful due to expert knowledge of Pradeep Dingankar.
PC: Pradeep Dingankar.

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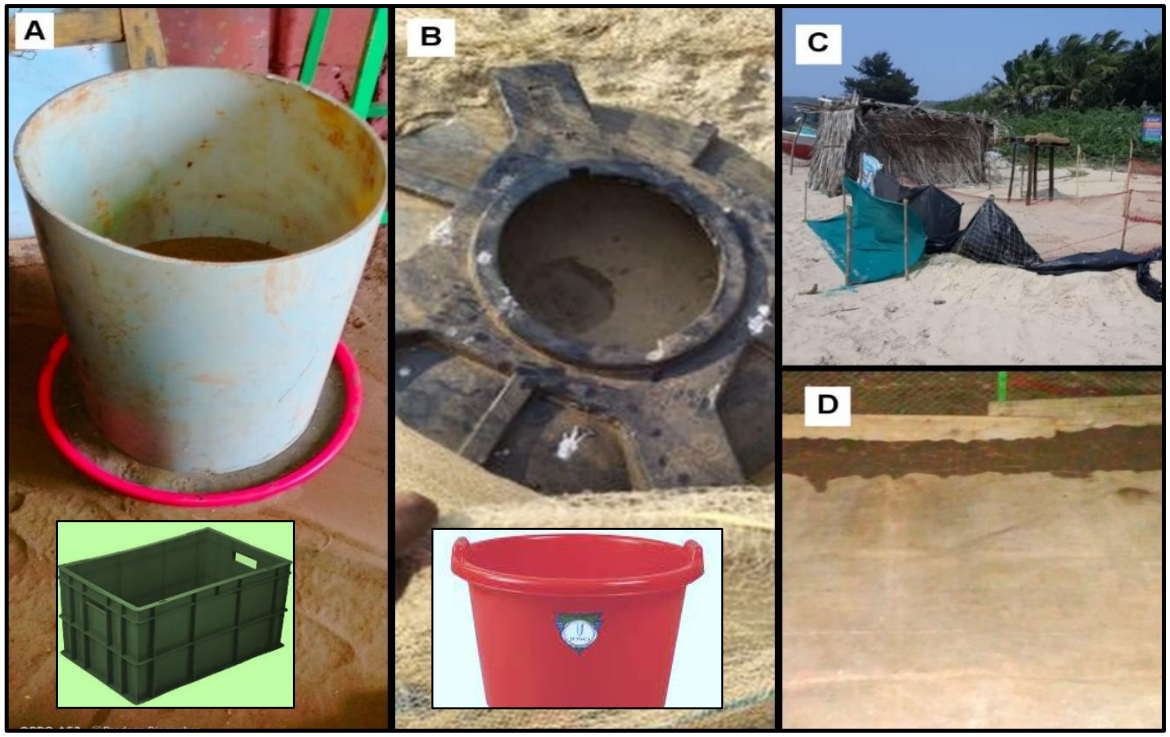

Fig 12: Pictural representation showing multiple approaches in protecting the turtle eggs during cyclone **A)** A broad PVC pipe on mortar pan or big size plastic crate. This will be a portable set-up in case the nest needs regular shifting**. B)** In case the nest is an advanced stage of incubation and needs protection from seawater flooding the site, such sintex tank (waste) cut in half or a broad plastic tub having both end open by removing the base can be placed over the nest. A plastic sheet covering the mouth will prevent the rainwater from entering the nest. **C)** In case of water flooding the hatchery unexpectedly during high tide or cyclone a protective plastic sheet deeply embedded in the sand at one end and other tied to the hatchery can be done facing seaward side. **D)** In case of light rain or A, B, C condition plastic sheet over the nest and the hatchery will provide dual protection from rain during the cyclone.
PC: A&D) Pradeep Dingankar, B& C) Sumedha Korgaonkar, Google images.

Significance of Olive ridley turtle conservation in Maharashtra at the national and global level

Globally there are eight regional populations of olive ridley turtles. Correspondingly eight regional management units (RMU) for conservation has been designated. The RMU was defined by IUCN-MTGS (Marine Turtle Specialist Group) to address region-specific management and research challenges. The Indian Ocean west is one of the RMU. The olive ridley's nesting on the west coast is a part of the Indian ocean west population whereas olive ridley nesting on the east coast is a separate population and considered in Indian ocean east RMU (Wallace et al, 2010).

On the west coast of India olive ridley nest in Gujarat, Maharashtra, Goa, Karnataka, Kerala and Lakshwadeep coast. The coast of Gujarat and Lakshwadeep has a prominent endangered green turtle nesting site that overshadows the olive ridley nesting. In the state of Goa, Karnataka and Kerala less than 5 nesting sites of this species is conserved. Olive ridley nesting was in sizable number in this state but with the construction of ports, increase tourism, egg and meat consumption the nesting sites reduced drastically (Sea Turtles of India, 2021). Olive ridley conservation in Maharashtra was initiated in 2002 by Bhau Katdare at Velas village with the state forest department. With the awareness programme, the consumption of meat and eggs were controlled. Gradually new nesting sites were added to the list of conservation. A model that was set up at Velas was duplicated at other sites. The Forest department took a keen interest in the conservation program. Now to date, more than 20 nesting sites are officially designated for turtle conservation. With this at the national level from the west coast of India, Maharashtra plays a major role in the conservation of this species. The contribution of India for this population of olive ridley at the global level is majorly due to Maharashtra state.

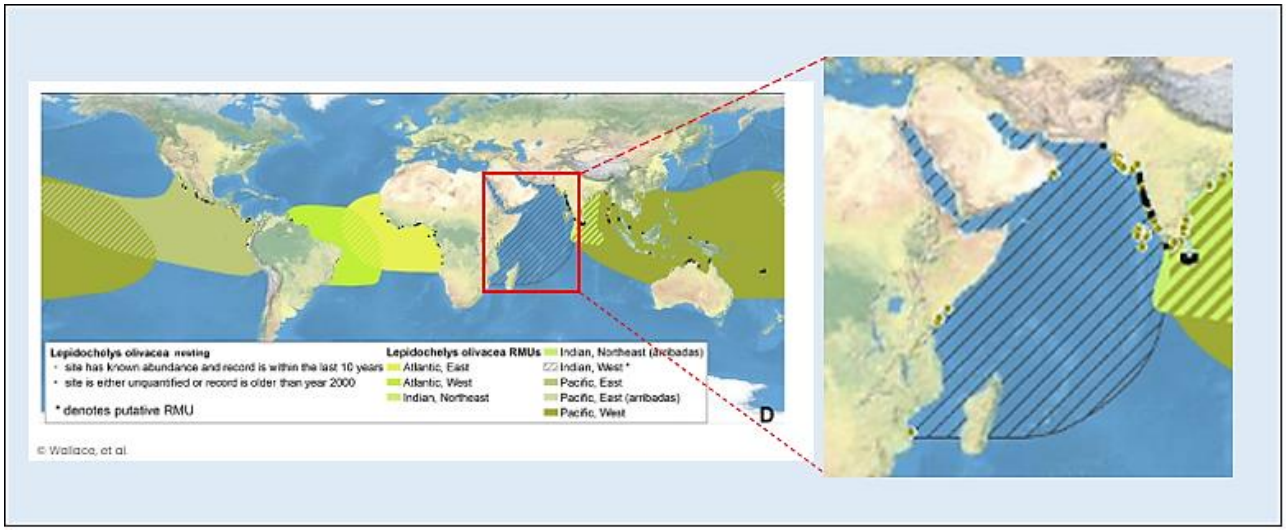

Fig13: Global status of olive ridley turtle. The Indian Ocean west, the 8th RMU for conservation of olive ridley turtle. It is considered putative due to lack of data related to migration, population, ecology, behaviour and genetic. The black dots represent nesting data older than the year 2000 and green dots indicate nesting data of olive ridley turtles in the last 10 years (Wallace et al, 2010).

At a global level, in the Indian Ocean west, RMU has known nesting site is the west coast of India, Pakistan, the coast of Oman, east coast of Africa. Recent nesting data of Pakistan is unavailable due to the loss of nesting sites. The nesting site on the east coast of Africa is the geo-political conflict site lacking conservation work for this species. A considerable conservation programme has been implemented in Oman (Rees et al, 2012). So, in the global scenario, Oman and Maharashtra state from India are the sites that play a significant role in the conservation of the Indian ocean west olive ridley population. With more than 20 nesting sites protected in Maharashtra, the forest department with its established set-up should try to increase the emergence % and ensure the release of healthy hatchlings by implementing advanced conservation management strategies.

The datalogger project has stepped up in advancing the conservation management strategies for this species contributing immensely to this RMU. There is a need to project conservation of olive ridley in Maharashtra at landscape level than considering a few nesting sites.

Recommendations

The following recommendations are the outcome of field-based observations made by Ms Sumedha Korgaonkar during the three years of this project. The recommendations are given after a thorough literature survey and intensive fieldwork. Dr K Sivakumar (Scientist F, WII) being an expert in the field of marine conservation was consulted for his inputs.

1) Temperature datalogger

a) The data logger should be used in subsequent years on major nesting sites. It not only helps in taking correct decisions regarding controlling the nesting temperature but also imparts a scientific attitude to the hatchery managers making them capable to face future challenges.

b) Among the study sites, 2-3 nesting sites needs to be changed to add new sites every year.

c) Manually noting the temperature data is recommended when there is a problem with data transfer. This will prevent the loss of data in case there is a problem with the data storage. In such a case, the temperature data can be taken once a day either in the morning or noon or evening as per the convenience of the hatchery manager. The time for noting the temperature data should be fixed throughout the nesting season.

d) Datalogger should be carried to field sites carefully in a box. As the sensory connection may get loose resulting in 0^0C or 50 ^{0}C readings.

e) Sensors are having an accuracy of $\pm 0.1^0$Cand are very sensitive. The tip of the sensors should be correctly placed in between the eggs to get correct readings. This year in the project it has been observed that in a few places the readings showed incorrect temperature which can be found with vast fluctuations in the nest temperature. If the sensors on the tip of the rod go deep out of the nest or on side of the nest it gives incorrect fluctuated temperature reading.

f) Opening of the IP65 box having the datalogger should be avoided on the field as it compromises the system exposing it to a hot and humid environment.

g) Datalogger should be checked for its functioning, data storage and data transfer before installing on the field.

h) Since the nesting season has shifted, the datalogger should be installed on all sites before January end. Hatchery managers should be made aware of the technicalities of the datalogger to make them capable of attending the datalogger in case any problems arise.

i) Basic data analysis software can be developed if required. Manual data analysis is possible with the help of a technical person.

j) A database is required to maintain the temperature data of nesting sites for future reference as it will help in policy decisions.

2) Casuarina plantation on nesting sites

With the constant threat of rising seawater, increase in temperature and flooding of hatchery erecting hatchery in sparse casuarina plantation is highly recommended. Casuarina plantation on the beach provide cooler ambient temperature and dispersed light which helps to maintain the nest temperature below its threshold temperature of 33^0C. In the current scenario of the highly skewed sex ratio of hatchlings due to an increase in temperature, it provides the most natural means to balance the sex ratio. **This is the breakthrough of the datalogger project.**

National Marine Turtle Action Plan (2021 -2026) launched on 21st Jan 2021 mentions in its objective 2 (2.2) 'a) Re-vegetate, where appropriate, frontal dunes at nesting beaches, with indigenous flora as far as possible, to provide visual barriers to coastal development and to restore appropriate beach temperature regimes b) Remove casuarinas from the important nesting beaches'.

The exotic Casuarina introduced in India in the 1860s has covered the entire coastline of India. In India, it's been planted by state agencies as a wind break and storm barrier. It has a definitive role in the prevention of sand/beach erosion. Mixed plantation of casuarina along with indigenous species has proved to be effective in preventing damage to human settlement during cyclones than monoculture plantation (Das et al, 2014). Though in countries like the US, South Africa it is a known invasive as it has replaced the native species and changed the soil structure, there is no reporting of it being invasive in India replacing the indigenous species (Invasive species compendium, 2021). Some precautionary measures have been highlighted in its plantation on mangrove sites (Das et al, 2014). In Maharashtra, it is present at least for more than 100 years and has very much become a part of the natural habitat. In coastal Maharashtra, the beaches are adorned by coconut plantations. At some places, the only indigenous tree that is found among the dune vegetation is Pandanus sp. also called Kewda. It forms dense impermeable vegetation along the coast. Pandanus currently is seen in few places and has been extensively removed to open the beaches for tourism and recreation.

In absence of big indigenous trees above the dune adjoining the beach, casuarina has proved to be beneficial. In our present study, it is a boon to turtle conservation when done with certain conditions. It also holds other important species like the nesting of the white-bellied sea eagle, roosting site of bats. It's a myth that no plants grow under casuarina when there are indigenous plants like pandanus that grows well underneath casuarina (Warrier, 2014). On the guidelines of the National Marine Turtle Action Plan, recently, the Maharashtra Forest Department has announced to stop planting casuarina along the coast. In absence of big indigenous trees surviving on the beach, this order seems irrational for the Maharashtra coastline.

A detailed scientific study about the plantation of casuarina and its role in beach biodiversity, soil dynamics and plantation strategy in the Maharashtra state is required through research institutes.

3) Scientific information dissemination about turtle conservation management with hatchery managers and forest department:

Problem1: Often a conflict arises between these stakeholders when no hatchlings emerge from the nest. Due to lack of scientific knowledge and appropriate assessment technique both come under pressure whenever reasoning is required. In absence of scientific knowledge to cover up and make things easy, it has been seen that fake data is presented about the emergence of hatchlings by both or either stakeholder. With the recently introduced m-turtle app this will get eliminated to a greater extent but still, there is a chance that the hatchery manager will be held responsible for 0% and low emergence rate.

Solution: The outcome of this project has explained the assessment technique to evaluate the nest by excavation, post-incubation period to find the exact cause of mortality.

The scientific knowledge related to low emergence % should be given to respective agencies by holding a district-level meeting in November every year.

The scientific knowledge gained through this project should be given to stakeholders for better decision making (Kolthare case).

Problem 2: In previous years (ie 2017,2018) training programmes were arranged by the range office whereby rigid rules and protocols regarding hatchery management were told. The rules and protocols did not have any scientific base and were given by hatchery managers from other sites. This has resulted in unnecessary confusion and given rise to many conflicts between the forest department and hatchery managers about hatchery management.

Solution: Hatchery managers should be used as resource persons to show relocation technique, selection of hatchery sites, mitigation of temperature for newly appointed hatchery manager or a new nesting site is selected for conservation management. Experienced hatchery managers from adjacent nesting sites will be the best resource to give such training.

The approach of turtle conservation management should be inclusive and accommodative of the knowledge of experienced hatchery managers. Conservation will be successful in the long run when the experience and observations of all the hatchery managers are taken into consideration. After every

3-4 years a proper in-person scientific survey should be taken to collect information about hatchery management.

Maharashtra- Turtle Action Group (M-TAG)

Alternatively, a Maharashtra Turtle Action Group (M-TAG) should be formed comprising of local NGOs, honorary wildlife wardens, forest officials concerned with turtle conservation along with a representative of hatchery managers from every district. The group should be constituted every year by November end before the start of nesting season. The hatchery managers from the respective district should be appointed on a rotational basis. The M-TAG should be formulated for the sole purpose of addressing conflicts between stakeholders and taking decisions related to hatchery management. At times an immediate decision is required to be taken in case of unforeseen threats like ant attack or cyclone, M-TAG would play a key role. Whenever required the core members of M-TAG can approach a competent authority that can give proper scientific solutions to the problems. This would reduce the unnecessary pressure on forest officials and hatchery managers when it comes to making decisions on critical issues. Such a platform could be beneficial to hatchery managers where they can present their observations and inform their problems.

4) Manual of hatchery management:

There is a need to have a manual for hatchery and conservation management for olive ridley sea turtles in Maharashtra. The manual will serve the purpose of providing correct information to hatchery managers and forest officials. It should be in two languages English and Marathi. A detailed account of the selection of hatchery site, hatchery building, relocation of eggs, labelling of the nest, providing shade, the rescue of trapped hatchlings, nest excavation, the release of hatchlings, protection from natural predators like jackal and ants, protection from the cyclone, Ipomoea root management etc can be included in the manual. The manual should mention different approaches to a common problem. The manual will serve as an applicable outcome of the datalogger project. **The manual should be a guidebook and not a rule book to the beneficiary.**

5) Hatchery managers

Local personnel were temporarily appointed by the forest department during nesting season for relocation of the nest and maintaining the hatchery. They are either fishermen, farmers, mason, coast guard or doing a proper job in the daytime which is their primary source of income. In addition to their primary job, they get involved in turtle conservation. Turtle conservation work gives them a

sense of satisfaction and status upliftment in their village. They are proud of their work and do it with utmost sincerity. Most of them especially the experienced once are emotionally involved in this work rather than for remuneration. Some of the hatchery managers with their experience of many years have developed amazing skills in handling practice and hatchery management. These people are the ones who will remain constant for many years in these sites than forest officials and researchers. They will be the one who has and will experience the change in nesting habits and sites due to climate change. They will be the ones reporting this change resulting in the improvisation of conservation management. Some of these people are conserving turtles for almost 20 years. Many of them are not on social media and prefer to do their work silently.

Problem 1: These experienced hatchery managers are often threatened with losing their job for reasons like

1) Refusing for doing extra unrelated work of forest department
2) Refusing to give bribes to forest officials
3) Unintentional mistakes in hatchery management

They are always at receiving end during crises. No lower grade forest official will take responsibility and give timely decisions during such crises. This results in non-reporting of the problem and at times covering up their mistakes out of fear of action by the forest department. In many cases, the hatchery managers are never given a chance to present their side.

Solution: These problems arise as the hatchery managers are only in contact with forest guards or foresters. They don't know whom to approach in times of conflict. M-TAG will help eliminate such conflicts. Their grievances could be addressed by such a group.

Recommendation: It's time to acknowledge the conservation efforts of experienced hatchery managers by the forest department of Maharashtra who are working for more than a decade.

Problem 2: On the other hand some hatchery managers have become possessive about their work. They get a false sense of achievement and become competitive with other hatchery managers. Such hatchery managers don't allow others to work with them. They also don't respect the work of fellow hatchery managers. They always criticize the works of other hatchery managers or try to dominate them. They will never share the information with others out of insecurity. They often mingle with the work of other hatchery managers without their consent. The worst is they take advantage of their proximity with forest officials often putting unnecessary pressure on other hatchery managers. Such

a dominant attitude of hatchery managers imparts a negative influence on conservation work. It demotivates hatchery managers who like to work silently on their sites. Some of the hatchery managers though experienced don't work responsibly.

Solution: A state-level gathering of all the hatchery managers once in 2-3 years will bring the hatchery managers together. Everyone should be given a chance to speak about their work. They should be told to share their experience with other fellow hatchery managers.

Competition between hatchery managers should be discouraged by the forest department.

Any person with such a negative attitude should not be encouraged by the forest department.

They shouldn't be allowed to interfere with the work of other hatchery managers without their consent.

The people with a positive attitude and cooperative nature should be used by the forest department as resource persons.

Subletting or transfer of job should not be allowed in any case in hatchery management.

If any hatchery managers have complained against another hatchery manager, they should bring this to the notice of forest officials in writing.

Recommendation: M-TAG will help address most of these issues.

6) **Relocation of the nest from other sites and relocation of relocated eggs in case of adverse conditions:** The experienced hatchery manager should be allowed to go to other low nesting sites and bring the eggs to their site. Transfer technique should be discussed with selected hatchery managers giving them the right protocol. To do these certain precautions are required like the use of a plastic icebox (no styrofoam box) to transfer the eggs. A large icebox will provide ample space and preserve the incubation heat inside the box. The eggs should not be removed from the nest in the harsh sun as it will result in heat shock and desiccation. The procedure should be done in the early morning or late evening. The eggs should be removed patiently without rotating eggs. The eggs should be placed along with a good quantity of sand from the nest which will prevent mortality of the hatchling due to movement shock. The position of the egg should be kept the same in the box and later in the newly transferred nest. After the removal of eggs, the box should be carried to the hatchery site by keeping it on the lap of a pillion rider of the two-wheeler. Relocation of such nests from only adjacent beaches should be allowed (max 5km north and 5 km south). The hatchery manager should inform the forest

department every time they attend to the call. The relocation should be done as early as possible. Cash reward should be given to the informer (in the case of Sindhudurg) and the hatchery manager should be given extra remuneration for his efforts.

Relocation of a relocated nest in case of flooding, cyclones, ant attack can be done successfully with the right protocol. Only experienced hatchery managers who have excellent handling skills should be allowed to do this.

7) Generalized attitude towards turtle conservation in Maharashtra

The olive ridley turtle nesting on the Maharashtra coast shows solitary nesting behaviour. Though they show natal homing (returning to the same nesting site where they were born) the solitary nesters are known to not show beach fidelity. That means the adult-born on X nesting site of Maharashtra will come back to nest in Maharashtra but might nest on beach Y or Z. Due to beach erosion, rise in seawater level some of the nesting sites may cease to exist and new nesting sites may come up in near future. It's time to look out for such sites. There is a possibility of one site having the greatest number of nests in one season and fewer nests in the next season. Unnecessary importance should not be given to a particular nesting site. This may result in ignoring other prominent nesting sites.

The conservation started in 2002 has succeeded in terms of establishing a network of local conservationists, bringing awareness among the locals, discouraging consumption of turtle meat and eggs. A highly efficient system involving the forest department and local conservationists is successfully established. Till now the turtle conservation management in Maharashtra looked patchy. Where more efforts are given to already established nesting sites whereas other prominent sites are ignored. Also, there is a generalized attitude when it comes to decision making. Through this project, we were able to show scientifically that the outcome of conservation cannot be the same everywhere owing to variation in habitat. The outcome of turtle conservation should consider the management work of major nesting sites encompassing all the three districts for that particular season. The conservation of olive ridley on the Maharashtra coast should be looked at as one unit and not many regional units. Conservation efforts should be region-specific but the outcome should be unified.

Conservation cannot be successful due to one person. There are initiators, executioners, regulators, investigators, negotiators, coordinators, volunteers who share equal responsibility in conservation management. Positive interaction between the Forest department, hatchery managers, local volunteers, local NGOs and researchers play an equal role in taking the conservation forward and making it a success.

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Appendix: Additional photo plates related to hatchery management.

Fig 14: The emergence of hatchlings at night and escaping under the cane basket placed over the nest is a common feature seen in the nesting site having fine sand. These hatchlings try to escape from the plastic nets of the hatchery. Many hatchlings successfully enter the sea but few are predated by Jackals present on site. Keeping the overturned cane basket on the nest with a jute gunny bag over it and embedded deeply in the sand is not useful on sites having fine sand**. A)** Live hatchlings escaping through the net in Dabhol. **B)** As an extra remedial action waste plastic net lying on the beach were collected and were put surrounding the nest in 3-4 layers. It was fixed deep inside the sand. It worked to restrict the hatchlings inside the nest. Overturned cane baskets were used to protect the emerged hatchlings from the crow. **C)** At Dabhol there is a rock embankment on the beach at one side made by Ratnagiri gas company. it prevents the escaped hatchlings from getting in the water. **D)** Wooden planks at the base of the hatchery to prevent hatchlings from escaping the hatchery at the Gaokhadi hatchery site. **E&F)** betel nut tree trunk used outside the hatchery to make a mount with sand. It prevents hatchlings from escaping the hatchery at night even when cane baskets are placed over the nest. PC: Sumedha Korgaonkar.

Fig 15: Rescue of hatchlings at Dabhol. This is a common feature seen at most of the sites. Remedial action would be to remove the sand from the mouth of the nest after 50 days of incubation to check the hatchlings. If no hatchlings are seen then the nest should again be closed with sand. **A &B)** hatchlings trapped in nest due to hardening of sand. **C)** removing the trapped hatchlings carefully from the nest **D)** keeping the hatchlings in the basket with sand for some time till they become active. Release them near water as usual. PC: Sumedha Korgaonkar.

Fig 16: Release of hatchings is done in between 6 -7 in the morning and 6 -7 in the evening. At many sites in the morning, traditional fishing is done near the shore in the morning. There is a possibility that the released hatchlings might get stuck in the fishing net. In absence of information regarding the migration of hatchlings after the release, this is an additional threat that is not taken into account. **A)** Fishing boats are seen near shore at 6.30 in the morning at Vayangani **B)** Fishing boats are seen near shore at Kolthare early in the morning. **C)** after 7 am the activity of sea birds like gulls and terns are seen on many sites. These birds can predate on hatchlings in water**. D)** Remedial action in a case where fishing gears are seen in the morning followed by sea birds on the beach making the release of hatchlings difficult. This is the technique developed by Suhas Toraskar of Vayangani and executed only during the fishing gear threats. The hatchlings are placed in a plastic tub with having a mix of moist nest sand and dry sand in a 1:1 ratio. The tub is covered by a moist jute gunny bag and the tub is placed in complete shade. This keeps the hatchlings dormant till the time of release in the evening. This method can also be used in case of hatchlings emerging during the daytime in high temperatures. Except for these two conditions, it will be unethical to practice this technique for showing the hatchlings to the public. PC Sumedha Korgaonkar

Fig 17: Erecting hatchery in casuarina plantation. **A)** removing the grass and leaves of casuarina from hatchery site **B)** after removal of grass **C)** Digging the sand at least till 2 feet for loosening the sand and checking for any roots. **D &F)** Site should be properly selected by the hatchery manager after considering the direct sunlight falling on the hatchery site. The hatchery should be built in sparsely placed casuarina plantation **E)** Completing the hatchery having double netting. PC Pradeep Dingankar.

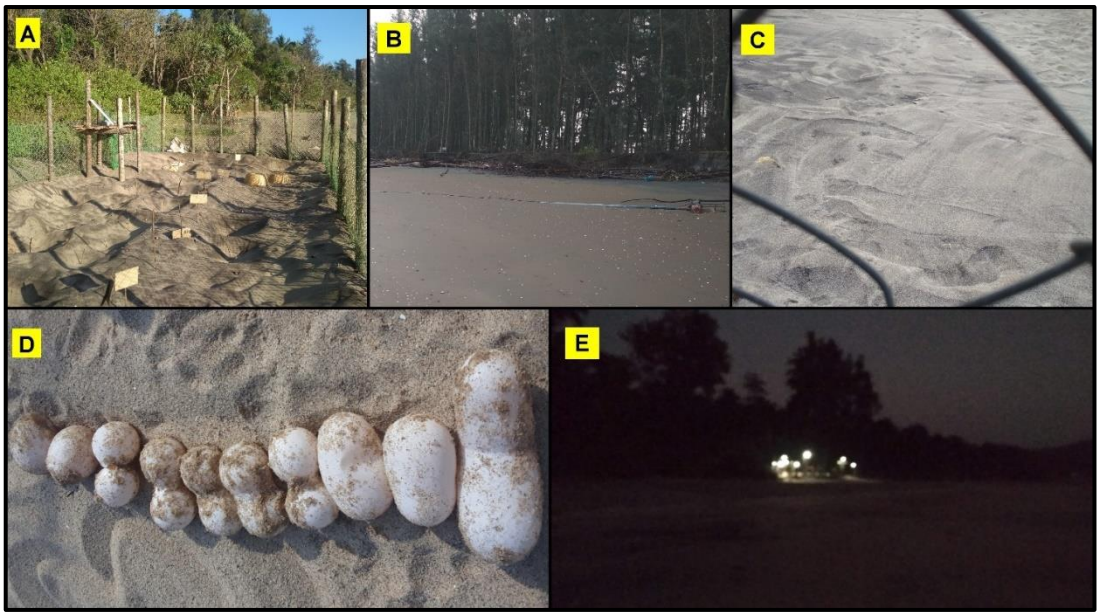
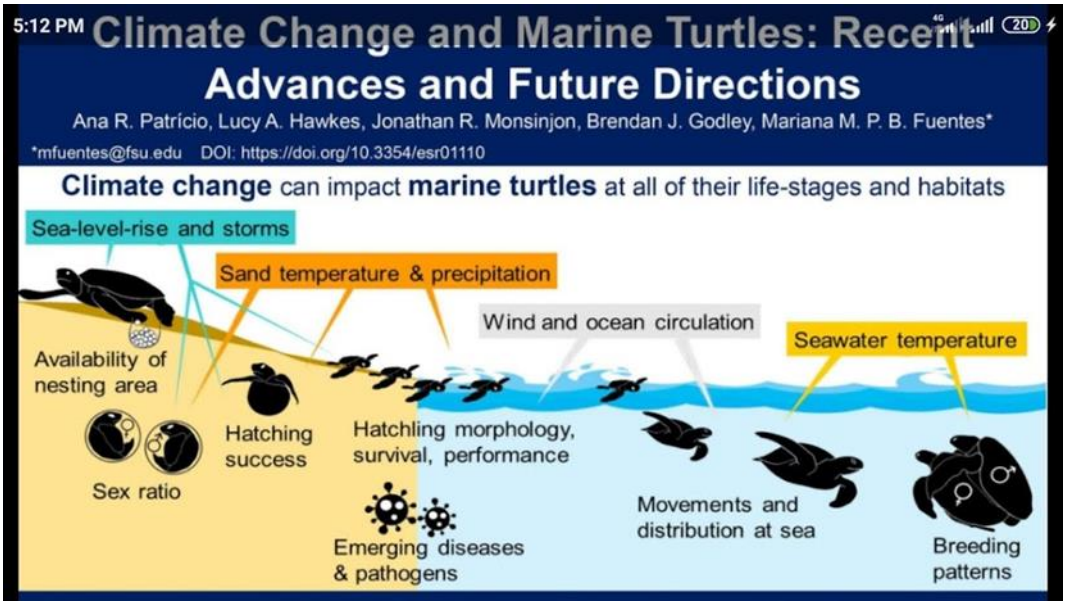


Fig 18: Other issues documented during the project period. **A)** unleveled sand in Kolthare hatchery due to the careless attitude of hatchery manager Kedar Todankar. **B)** Severe beach erosion is seen at the Gaokhadi nesting site. **C)** Pugmarks of palm civet seem inside the hatchery. **D)** Abnormal eggs from single nest seen during relocation photo-documented by Suhas Toraskar. **E)** Lights from the hotels adjoining the beach on the Kolthare nesting site. We observed the turtle returning to the sea without laying eggs due to lights. The lights attract feral dogs who generally are not seen on dark beaches at night. The manager at first refused to act as it was tourist season but later obliged and switched the light during nesting season. The nesting sites having hotels adjoining beaches should be identified and notification to gram panchayat regarding the use of lights during nesting season should be given by the Forest department. Also, remedial actions like using shades and types of light should be suggested to such hotels to ensure a positive balance between tourism business and prevention of abandoning of the beach by turtles. PC Sumedha Korgaonkar, Suhas Toraskar.

Studying the incubation temperature of a nesting population of olive ridley turtles (*Lepidochelys olivacea*) in the coast of Maharashtra with advance data logging system (Phase III) – Submitted by Sumedha Korgaonkar (Nov 2021).

Fig 19: A) a sturdy entrance to hatchery built by Rakesh Dhopavkar of Kelshi by using readily available material. **B)** weighing of hatchling (sample size 10 per nest) before releasing. **C)** Hatchery site at Vayangani beach spread on the beach. It is a small fishing village. The site is highly ignored by regional forest department resulting in conflicting issues like many people patrolling at night with high intensity torch light, nest stealing etc. There is a need of intervention of forest department to resolve such issues and provide resource to erect a proper hatchery. The vegetation adjoining the beach.

PC: Sumedha Korgaonkar



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Project Team

Funding agency

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महाराष्ट्र वन विभाग

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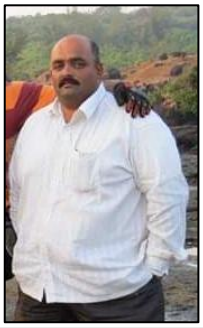
Ajinkya Keluskar - Anjarla

Pravin Todankar - Kolthare

Dattaram Vanarkar - Dabhol



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Suhas Toraskar - Vayangani

Studying the incubation temperature of a nesting population of olive ridley turtles (*Lepidochelys olivacea*) in the coast of Maharashtra with advance data logging system (Phase III) – Submitted by Sumedha Korgaonkar (Nov 2021).

Temperature Datalogger developed and customized by

SYSLAB
AUTOMATION PVT. LTD.

Shri Kishor Jambhekar
Syslab Automation Pvt Ltd
Address: 98A/15B, PELCO Park,
Hadapsar Industrial Estate, Pune
411013, India

Temperature Data logger system customized for use in hatchery.

Data logger unit encase inside IP 65 box with sensor stick attached.

Antenna to receive mobile network signal

12V solar panel with battery attached

The project work was presented at International Congress for Conservation biology (ICCB 2021) held online from 13th – 17th Dec 2021

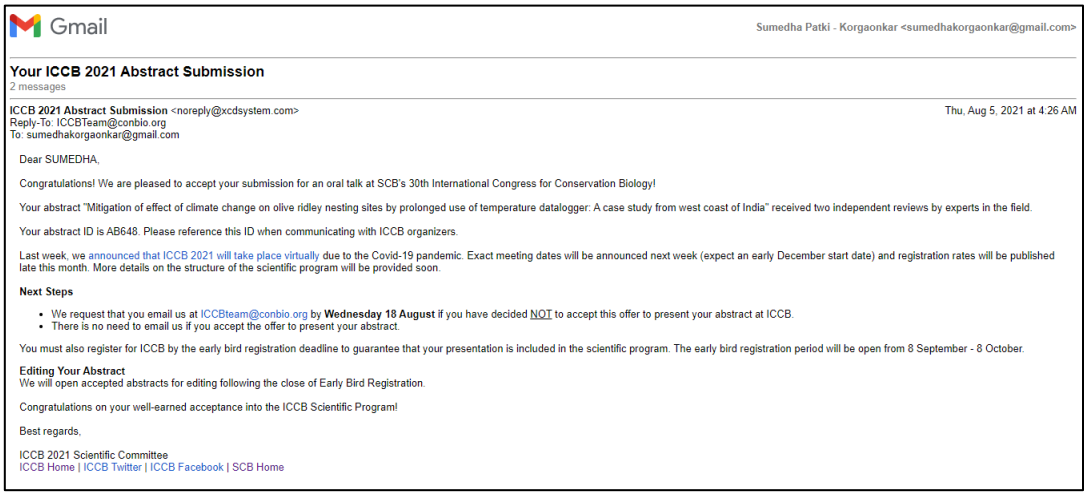
Oral presentation

Title:

Mitigation of effect of climate change on olive ridley sea turtle nesting sites by prolonged use of temperature datalogger system: A case study from the west coast of Maharashtra, India.

Abstract:

A major shift in nesting season from winter to summer nesting within two decades has exhibited the negative impact of climate change on a nesting sea turtle. With summer nesting the incubation temperature of the nest goes above the threshold temperature of 33^0C. It results in a decrease in the hatching and emerging success rate of the hatchlings with fewer chances of their survival in open seas. Though the use of temperature dataloggers is not new to conservation management in sea turtles they are often expensive, have a short shelf life and are used only for research. An indigenously developed temperature datalogger system customized for use in extreme environmental conditions on the beach is used in olive ridley hatchery on the west coast of India. Installed on seven major nesting sites spread across >250 km, it has an advance, Global system for mobile communication (GSM) system for data collection. The incubation temperature of the nest is attributed to ambient air temperature, the position of the hatchery and the microenvironment of the nest. The continuous temperature monitoring of the nest has ensued the use of appropriate mitigation techniques specific for the nesting sites. We demonstrate that such varied mitigation technique specific for nesting sites has been successful in increasing the hatching and emergence success rate by keeping the incubation temperature below the threshold. We conclude that the prolonged use of a monitoring system will facilitate restraining the climate change effect on the nesting sites, reducing the stress on the survival of the species.



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